

Executive Leadership

TSUNAMI WARNING-SIRENS ON THE SHORES OF THE PACIFIC

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CERTIFICATIONS STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotations marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

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Abstract

The problem is: North Lincoln Fire & Rescue operates tsunami-warning sirens to warn of approaching tsunamis; no uniform standard for tsunami-siren warning system exists for the five Pacific Rim States. Lack of a uniform warning standard may result in inconsistent warning signals, and result in confusion and endangering the public in regards to the proper actions to take during a Tsunami Warning.

The purpose of this research is to accumulate a base of knowledge pertaining to the siren warning systems currently in use today which are intended to warn the public to take immediate action to avoid harm. Examples of these types of systems are tsunami, dam failure, or hazardous material release. This research will assist in developing a comprehensive local tsunami-siren warning policy.

A descriptive research method was used to answer the following questions: What type of public tsunami warning systems are currently used in the five western states—Oregon, California, Washington, Alaska, Hawaii and locations in and around the Pacific? What recognized standard currently exists for public siren-warning systems in the United States? Does evidence exist that supports one type of siren sound being more effective than another? What other uses are facility-mounted warning sirens being used for within communities located in tsunami zones?

A survey tool was used to assist in answering questions one, two and five. Literary review and examination of existing policies will be used to answer questions two, three and four.

Results show that there is diversity in how warning sirens are being operated and that there is a desire for a uniform siren standard among those surveyed. Recommendations include an evaluation of public understanding of North Lincoln Fire & Rescue's tsunami siren system,

and future researchers should consider research on how people respond to public warning when designing a warning system.

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Introduction

In Hilo, Hawaii in 1960, 61 people were killed and 282 were injured by the tsunami generated by an earthquake thousands of miles away in Chile. These deaths occurred even though warning sirens sounded giving advance warning of the approaching killer wave (USGS 1999). Research conducted in the 1960's showed that the understanding of the meaning and uncertainty in understanding played a key roll in these deaths (Gregg 2006).

The problem is: North Lincoln Fire & Rescue operates tsunami-warning sirens to warn of approaching tsunamis , and no uniform standard for tsunami-siren warning system exists for the five Pacific Rim States. Lack of a uniform warning standard may result in inconsistent warning signals and result in confusion and endangering the public in regards to the proper actions to take during a Tsunami Warning. When a siren is sounded, a message is being sent. Each person hearing the siren will interpret its message, and based upon how the receiver interprets the message, will take one of three actions. First, they may take no action and continue with planned activities; second, they could seek more information; and finally, they may take protective action (Sorensen 2000). If the listener lived in a community where volunteer firefighters were alerted by sirens, they likely would take no action; if they lived where sirens were used to warn of possible dangers, seeking more information is a logical response. If the listener lived in a different coastal community protected by sirens, we might assume their actions would be based upon their community's expectations. If sirens are able to convey a voice message then communications are improved, assuming that the voice message is understood and interpreted in the desired manner.

The purpose of this research is to accumulate a base of knowledge pertaining to the siren warning systems currently in use today, which are intended to warn the public to take immediate

action to avoid harm. Examples of these types of systems are tsunami, dam failure, or hazardous material release. This research will assist in developing a comprehensive local tsunami-siren warning policy.

A descriptive research method was used to answer the following questions: What type of public tsunami warning systems are currently used in the five western states—Oregon, California, Washington, Alaska, Hawaii and locations in and around the Pacific? What recognized standard currently exists for public siren-warning systems in the United States? Does evidence exist that supports one type of siren sound being more effective than another? What other uses are facility mounted warning sirens being used for within communities located in tsunami zones?

Background and Significance

North Lincoln Fire & Rescue (NLFR) was formed eleven years ago with the merger of two fire districts. Each of these districts provided emergency services to the community for more than sixty years. North Lincoln Fire & Rescue is a volunteer fire agency served by a paid administration, comprised of seven full-time and one part-time personnel. North Lincoln Fire & Rescue is governed by a five-member district board, which hires the fire chief to administrate the district and set policies NLFR responds to approximately 1500 emergency calls each year, relying upon sixty volunteers to provide emergency services.

Services being provided are firefighting, water rescue, emergency medical service (EMS), vehicle extrication, hazardous materials first response, and fire prevention programs in the schools. The fire district maintains six fire stations and 28 emergency vehicles to provide services to an 80 square-mile district, which includes the City of Lincoln City, a coastal resort community.

Lincoln City is located on the 45th parallel, situated on the coast of Oregon. According to City-data.com (2008). The City covers 5.33 square miles and fronts approximately 8-miles of Pacific Ocean; the resident population was 7,969 as of July 2007. The population is 54% female, 46% male, with the median resident age being 41.8 years. Devils Lake is a 680-acre fresh water lake, bordering three miles of the east side of Lincoln City. Devils Lake out-flows to the Pacific through the D-River, once known as the shortest river in the world (Preservation Association of Devils Lake 2008). Surrounded by State and Federal timberland, historically the region was dominated by the timber industry providing most of the jobs in the community. Over the last couple of decades, the community transitioned into a resort and retirement community. Tourism now provides the majority of employment (Central Coast Economic Development Alliance 2008).

According to the Oregon Department of Geology and Mineral Industries ([DOGAMI], 2001), a tsunami is a series of waves generated by a sudden displacement of water and can be caused by one of the following: vertical movement of the ocean floor caused by an earthquake, underwater volcanic eruption, meteor impact or a coastal land slide (on land or underwater). These tsunami waves travel outward in all directions from the source, traveling across the ocean at approximately 480 miles per hour. In deep water, these wave may go unnoticed, being only one or two feet in height. However, depending on the topography of the ocean floor and the amount of water displaced, the wave's height will rise as it approaches and moves ashore. Tsunamis are categorized by two general types—distant and local. A distant tsunami will take hours to reach the point of inundation due to the distance traveled. In a local tsunami, the source is close to the inundation point and travel time is measured in minutes. Local tsunamis may also be regional, caused by a smaller event such as a landslide, and may only affect a small region in

contrast to a subduction zone earthquake which will be a Pacific-wide event—local to some and distant to others (DOGAMI 2001).

For the purpose of this research, the focus will be on warning the public of a distant tsunami, or a small regional tsunami where other natural warnings such as an earthquake were not felt in the area to be warned. In contrast, the local tsunami caused by a subduction zone earthquake, the primary warning is the earthquake; sirens or other methods are secondary. In general, tsunami warning is broken down to detections by tsunami warning centers which communicate the warning to the national level, national to state, state to local, and finally the local emergency managers to the public. This research is addressing the final stage of the warning, that being communication to the public by local emergency management officials; more specifically, the use of outside warning sirens to communicate the warning.

Outdoor warning sirens come in two basic designs—electronic and electro-mechanical. The electro-mechanical siren is a rotor in a housing that spins, driven by an electronic motor. The speed of the rotor in the housing determines the Hertz range of the sound being produced. A mechanical siren is limited in the variations of sounds, generally capable of producing an Alert and an Attack tone. In an attack tone, sound sweeps from lower to higher tones that cycle up and down; and an Alert tone sweeps from a low tone to a higher pitched tone and holds the pitch in a continuous solid tone. An electronic siren is essentially a loudspeaker siren that is capable of various different sounds including voice messages. An electronic siren can produce all the sounds of mechanical and other distinct sounds such as bells, chimes, hi-low and even cows mooing (DOGAMI 2001).

At-risk populations to tsunamis in Lincoln City include 1,321 residence, 1,611 employees, and an average of 6,052 visitors daily to State park facilities. In addition, 28 hotels

occupy the inundation zone. Economies at risk include 38% of the tax-parcels valued in 2005 at \$436,790,330, 101 or 13% of businesses responsible for over \$137,000,000 in sales volume (Wood, Nathan, 2007).

North Lincoln Fire & Rescue and the City of Lincoln City partner tsunami warning with public education in Lincoln City. Warning is disseminated by reverse -911, Emergency Alert System (EAS) operated by National Oceanic and Atmospheric Administration (NOAA), and outside warning sirens and vehicles that are driven through areas using sirens and loud speakers where other systems have no coverage.

Oregon Senate Bill 557 enacted by the 73rd Oregon Legislative Assembly – 2005 Regular Session, requires the development of standards for tsunami warning, evacuation planning and public education materials. Oregon Emergency Management (OEM) and DOGAMI are charged with facilitating broad distribution to transient lodging facilities in the tsunami inundation zone on the Oregon coast. In July 2006, Jay Wilson (Earthquake, Tsunami and Volcano Program Coordinator for OEM) formed a 12-member work group to address the standardizing of the tsunami warning systems as called for in Senate Bill 557. The Oregon Senate Bill 577 Uniform Tsunami Warning Signal Work Team was made up of federal, state and local officials. It was tasked with reviewing existing research and practices regarding tsunami warning systems, and to make recommendations on a uniform state standard on tsunami warning signals as required by Senate Bill 557 (Wilson 2006). Recommendations were made by the work group, but no adoption of a state standard has taken place to date. Today, the Oregon Coast Fire Chiefs, a standing committee of the Oregon Fire Chiefs Association (OFCA), is actively working toward the adoption of a standardized warning system for the state as called for in Senate Bill 557. This researcher served as a member of the Oregon Senate Bill 577 Uniform Tsunami Warning Signal

Work Team and is an active member of the Oregon Coast Fire Chiefs. It is this researcher's intent to help facilitate the goal of a standardized state warning system by conducting research specific to the use of outdoor warning sirens in warning the public.

This research relates directly to two of the U.S. Fire Administration's goal. The first is to promote within communities a comprehensive, multi-hazard risk-reduction plan led by the fire service organization. The second is to respond appropriately in a timely manner to emerging issues (USFA 2003). This research relates to the National Fire Academy's (NFA) Executive Leadership course, chapter 10 networking, chapter 11 negotiations, and chapter 12 influencing styles (NFA 2005).

Literature Review

What types of public tsunami warning systems are currently used in the five western states—Oregon, California, Washington, Alaska, Hawaii and locations in and around the Pacific? Information reaches the local emergency managers after an earthquake occurs by the following method: the various tsunami warning centers analyze the event and determine if a tsunami may have been generated. The West Coast and Alaska Tsunami Warning Center (WC/ATWC), located in Palmer Alaska, is responsible for issuing warnings to Oregon. If a potential tsunami threat is detected, WC/ATWC issues a warning to the National Weather Service (NWS), email, and text messaging to pagers and cell phones. The NWS disseminates the warning through NOAA Weather Radio-All Hazard, the Emergency Alert System (EAS) and the Emergency Managers Weather Information Network. State emergency managers receive the warning from FEMA's National Warning System and NOAA Weather Wire (WC/ATWC 2008). State officials disseminate the warning to the County emergency managers who follow local procedures for warning the public. Local officials may have a number of tools available.

Depending upon the community, these may include but are not limited to: sirens, local radio, local EAS, pagers, phone systems and door to door (DOGAMI 2001).

Automated telephone notification systems are being utilized to warn of tsunami and other emergencies by some local officials in California, Oregon, and Alaska. These systems deliver a pre-recorded message, giving the nature of the emergency and instructions for protective action (DOGAMI 2001).

National Weather Service broadcasts tsunami and other warnings using what is termed the NOAA Weather Radios (NWR). According to information found on the National Weather Service ([NWS],2008) web site, they have 1000 transmitters that cover all 50 states, adjacent coastal waters, Puerto Rico, the U.S. Virgin Islands and U.S. Pacific Territories. The NWR system is networked with the EAS and transmits information on weather and other hazards including tsunami in conjunction with the EAS. NOAA Weather Radio all hazards transmitters broadcast on one of seven VHF frequencies from 162.400 MHz to 162.550 MHz. and are programmable to activate on specific types of alerts.

The EAS system replaced the Emergency Broadcast System in 1996. According to the Federal Communications Commission ([FCC], 2008), the EAS systems requires broadcasters, cable television systems, wireless cable systems, satellite digital audio radio service (SDARS) and direct broadcast satellites (DBS) to provide communication capabilities to the President during National emergencies. The system is also available to state and local officials. The NWS is authorized to use the EAS system for emergency weather information, and this information can be disseminated to specific areas within the network. Local officials may also utilize the EAS to the public with the corporation of local radio, television and cable networks. The reliability of the local EAS will depend on local planning and cooperation from local media, and

may not be required to participate. Issue such as lack of back-up power and un-staffed broadcast facilities can also affect reliability of the system (DOGAMI 2001).

The National Oceanic and Atmospheric Administration's Emergency Managers Weather Information Network ([NOAA-EMWIN] 2008) is operated by the NWS. EMWIN is a network to provide emergency managers data on NWS warnings, watches and forecasts using radio, satellite, and internet in almost real time. A couple of advantages of the EMWIN systems is that the data received is free after the initial cost of hardware, and data is available from satellite downlink. The system is primarily designed for emergency managers and not public warning (DOGAMI 2001) (NOAA-EMWIN 2008).

Hawaii's tsunami warning system is part of a statewide all hazardous warning systems utilizing the EAS, EBS, mechanical sirens, electronic voice sirens, and low flying air craft announcing evacuation (DOGAMI 2001) (Gregg 2006) (Hawaii 2006). The siren system operates following the outdoor warning system guide (FEMA 1980) recommendation of a solid 3-minute blast. The intent of the siren is to have the public seek more information from radio and other media; the EAS and EBS are activated simultaneously broadcasting instructions for protective action (DOGAMI 2001).

Jefferson County (2008) Washington operates an "all hazards alert broadcast system" (AHAB) that utilizes three outdoor warning sirens. The siren can be activated locally by the county Department of Emergency Management, Police & Fire Departments for all hazards, Fort Worden authorities for hazards affecting the Park, and Port of Port Townsend for hazards affecting the port area. The State of Washington Emergency Management Division can activate for tsunami warnings using a remote satellite link. All three sirens are capable of voice messages in conjunction with siren alert; the detailed protocol was not included in acquired document. The

siren function is audible beyond the understandable range of the public address (PA) function of the sirens. The sirens can be activated individually or together as required. The AHAB are used for tsunami warning and other immediate hazards to life where rapid action is required by persons at risk (Jefferson County 2008). As of November 2007, Washington State has 49 operational AHAB sirens located in communities at risk of tsunami, as reported in the State of Washington report to the National Tsunami Hazard Mitigation Program annual meeting ([NTHMP] 2007).

The Kenai Peninsula Borough (2008) in Alaska warns the public of potential tsunami and other emergencies by one or more of the following methods: the American Emergency Notification (AEN), Siren Alert and Warning Systems (SAWS), AHAB, EAS, mobile public address and door-to-door alerts are utilized in various areas throughout the borough. The method of warning is selected depending upon what system(s) is available in the area to be warned. Siren systems consist of both electro-mechanical sirens referred to as SAWS, and electronic sirens with voice capability referred to as AHAB. The AHAB system is consistent with Jefferson County, WA and Hawaii's use of the AHAB system (Hawaii 2003), (Jefferson County 2008).

At the National Tsunami Hazard Mitigation Program's (2007) annual meeting in November of 2007, the State of Washington reported having 49 operational AHAB sirens. These sirens are controlled both locally for all hazard broadcasting and by the state by satellite control for tsunami warning (Jefferson Co. 2008), (NTHMP 2007).

In British Columbia, tsunami warnings are initiated by the WCATWC in Palmer by the Provincial Emergency Program after receiving notification from WCATWC, who then notifies local officials, stakeholders and the media. This notification is transmitted by various means including telephone, fax and internet. Local officials are responsible for warning the public at

risk (Anderson 2006). In 2006 British Columbia published BC Tsunami Warning Methods “A Toolkit for Community Planning” Anderson (2006) identifies warning dissemination methods in two categories—general and specific methods. General being mass media wide broadcasting and specific more targeted to groups, agencies or individuals. General methods include sirens, radio, television, internet, community boards and newspapers. Examples of specific methods are two-way radios, pagers, tone-alert radios, telephone, cellular, email and similar technologies.

Anderson (2006) identifies sirens as one of the most reliable means of outdoor mass notifications. He also states that when sirens are properly located, they can reach populations in isolated areas where other technology such as telephone, cell phones, television and radio are unavailable. Anderson goes on to say that signal or voice messages should be clear, concise, distinct and uniform over as large a region as possible. Anderson (2006), when discussing outdoor warning methods, states the basic requirement is that the listener knows what the sound means and that specific purpose sounds are most effective, but acknowledges to be unaware of any universal warning sounds for tsunamis or floods.

What recognized standard currently exists for public siren-warning systems in the United States? Standards for the use of outdoor warning sirens in the United States were set by FEMA in the Outdoor Warning Systems Guide CPG 1-17 (FEMA 1980). The intent of CPG 1-17 was to establish a guide for the planning and use of outdoor warning sirens, air horns and similar devices. FEMA (1980), in the guide, gives recommendation for an Attack Warning signal and Attention or Alert Warning. The attack signal is described as a three to five minute wavering pitch siren or a series of short bursts on horns. The meaning of the signal is “protective action should be taken immediately” (FEMA 1980 p.5), and suggested to be used for enemy attacks, or accidental missile launch warnings. The alert warning is a three to five minute steady signal from

siren or similar device and may be used by local government to warn of peacetime emergencies. The intent of the alert warning is to “turn on radio or TV, listen for essential emergency information” (FEMA 1980 p.5); it is also permissible for other meanings or required actions to be established by local officials. FEMA (1980) also allows for a third distinctive signal to be established by local government for other purposes. An interesting note to the FEMA Outdoor Warning Systems Guide, The White House (2006) issued Executive Order 13407 on June 26, 2006. President Bush directing the updating of Public Alert and Warning System and the Outdoor Warning Systems Guide certainly falls under this order. No information could be found regarding progress of on Executive Order 13407 as it would relate to outdoor warning systems.

Hawaii has a statewide warning system which utilizes sirens as an outdoor warning method. According to Gregg, C.E. (2006), Hawaii uses the attention alert signal, a steady 3-minute tone which means to tune to radio or television for more information.

Does evidence exist that supports one type of siren sound being more effective than another? After searching the internet and the Lincoln County Library catalog, this researcher could find no specific research that evaluated different types of siren sounds for their effectiveness of being heard. Information was available related to sound and the hearing of sirens in general. FEMA (1980) explains that electronic voice sirens are more effective because of the ability to deliver messages to the listener. Although voice messages cannot be understood over the same distances as a siren can be heard, more sources would need to be installed to cover the same area. FEMA (1980) says two factors determine if sirens are effective in alerting the public. First, the siren sound must be able to be heard over the ambient noise level of the surroundings of the listener. Second, it must get the attention of the listener. To do this, studies have shown that the siren must exceed the ambient noise level by 9 decibels. Anderson (2006) states the

standard rule for overcoming background noise is 10 decibels over the ambient noise level, and that normal surf and wind is approximately 70 decibels. Therefore, a siren used in a beach environment would need to produce a minimum of 80 decibels to the listener.

Sorensen, J., and Mileti, D. (1990) state that people do not remember what different siren sounds mean, but will seek out information if sirens are sounding for an extended time period; therefore, they recommend sirens are best used as an alert device to prompt people to seek more information. Sorensen, J., and Mileti, D., do not recommend sirens alone be used to prompt a protective action from the public. The exception to this is where drills are conducted to the point that the actions become an automatic. The research of Sorensen, J., and Mileti, D., (1990) influenced this researcher to seek more information as to the factors that affect the effective use of warning sirens. Sorensen, J., and Mileti, D., (1990) describe the warning response process as: hearing, understanding, believing, personalizing, deciding and responding. Hearing is only one of the five steps of the warning process. Factors affecting the message being heard are: actual inability to hear due to physical constraints, selective perception, and inattention to media delivering message. Understanding is not literal if the message is comprehended, rather how it is understood. An example is that a strong wind to one person may mean their trashcan may blow over; to someone else it means their roof will be blown off. Believing is what level of credibility and accuracy the listener attaches to the message; some say that too many false warnings create a cry-wolf syndrome lack of response by the public. Although, Sorensen, J., and Mileti, D., indicate that in general this has not been proven to be true, personalizing the message is how the listener measures the risk or impact to themselves, family or group. Deciding and responding is the stage where the listener has processed the items above and decides what actions to take, if any. Sorensen, J., and Mileti, D., point out another important factor to consider. People go

through the stages of the process each time new warning information is received, and most people do not wait for more information but will actively seek it out, which explains why phone lines become overloaded and 911-centers phones are jammed at the onset of an event.

Hawaii has operated a statewide siren warning system since 1947. The system has not failed to operate in alerting the public of a tsunami warning during that time (Hawaii County 2005). A survey conducted in 2006 shows that understanding of sirens has not increased significantly from the low levels of the 1960's. Awareness of the siren tests were high, on average 84% of those surveyed were aware of the siren tests; and 77% were aware tests were conducted monthly. When asked the meaning of the siren, 69.7% of students and 50.4% of adults answered "don't know", while 47.9% of students and 48.1% of adults answered "other" (emergency, disaster, alert, tsunami, flood, etc.). Less than 1% of students and 13.1% of adults answered correctly—tune to radio/television (Gregg, C.E 2006).

In summary, as might be expected, the literary review showed there is a wide variety of warning systems being utilized for tsunami warnings (DOGAMI 2001). In part, this is for the sake of redundancy; other times it is due to limited technology available to the community. In general, there are copious amounts of information available regarding tsunami and warning systems; specifically related to outdoor warning systems the list narrows dramatically. The underlying intent of this research is to provide information that will help facilitate the implementation of siren warning systems that are heard and understood, and to prompt the desired response from the public. A gap in research available that affected research question three was: Does evidence exist that supports one type of siren sound being more effective than another? Sorensen, J., and Milet, D., (1990) point out that few empirical findings show why warnings were or were not heard; they speculate that few have researched this because an

assumption is being made that warnings are being heard. Sorensen, J., and Mileti, D., go on to point out that evidence exists to show it would be inaccurate to assume that, because warnings are issued, they were heard. Information was available that addressed effectiveness of sirens and the public understanding Gregg, C.E., (2006). In research question three, I assumed that if the siren is heard, then a proper response will follow. Based on the findings, this is a poor assumption, as shown by Gregg, C.E., (2006) survey—Hawaii. In light of research available, question three was addressed as to factors that influence public reaction and understanding of warning sirens.

Procedures

A survey was conducted to assist in answering the following questions: What type of public tsunami warning systems are currently used in the five western states—Oregon, California, Washington, Alaska, Hawaii and locations in and around the Pacific? What recognized standard currently exists for public siren-warning systems in the United States? What other uses are facility-mounted warning sirens being used for within communities located in tsunami zones? Approximately 80 surveys were distributed and 21 responses were received from six States: British Columbia, and New Zealand.

The purpose of the survey was to gather information from agencies using warning sirens to assist in answering the questions above. A draft survey was developed and tested on July 25, 2008 while attending the Oregon Coastal Fire Chiefs meeting. Based upon the results of the test survey, minor modifications were made to questions, and two additional questions were added. I contacted Althea Turner, (Earthquake, Tsunami, and Volcano Program Coordinator for the State of Oregon). I explained the project and purpose of the survey and she provided a list of contacts

involved with tsunami emergency planning in Oregon, and for her counterparts in California, Hawaii, Alaska, Washington and Guam.

A group email with attached survey was sent to 50 Oregon agencies. Individual emails and hard copy of the survey, and a request for contacts of persons or agencies operating outdoor tsunami sirens were sent to the State Coordinators of Washington, Hawaii, Alaska, California and Guam. The survey was also sent to a listing of 17 former EFOP classmates, one of which was the Fire Chief of Wellington. I searched the internet for information regarding British Columbia tsunami warning systems and identified Jim Price, the Senior Regional Manager of Vancouver Island, North East, and North West Regions of British Columbia. Mr. Price forwarded surveys to approximately six agencies in British Columbia (BC) and provided web sites for additional information regarding tsunami warning and planning in BC. An internet search was also conducted for agencies in California, Washington and Alaska to determine agencies that might be operating tsunami warning systems. Ervin Petty, Emergency Management Specialist II for the Department of Military and Veterans Affairs in Alaska, provided a listing of the five Tsunami Ready communities in Alaska, and surveys were sent to each.

The internet was used extensively during this research. Google search engine was utilized using key words: tsunami, sirens, and public warning in various combinations. The online catalog of National Emergency Training Center, Learning Resource Center was also accessed. Most information useful to this research was found outside the fire service. Articles such as "Tsunamis: A Wakeup Call for the U.S." by Collins (2005) documents the tsunami threat as an emerging issue but did not address the specific research questions of this project.

Limitations to this research: The survey was targeted to agencies that disseminate tsunami warnings directly to the public, specifically using outdoor sirens. This researcher is

unaware of a complete listing of agencies that operate tsunami warning sirens and had limited success in reaching the survey target audience. Limited response to the survey was also an impact regarding the results of the survey. Time to commit to research is always a challenge, and given the time deadline of the EFO program, this limits the research in quantity and quality.

Results

Surveys were returned from 21 agencies. It should be noted that those responding were not equal in respects to jurisdictional responsibility: some represented individual Cities, in the case of Hawaii a Statewide system and New Zealand a National system. Numbers of response to the survey by region were: California (two), Washington (one), Alaska (four) Oregon (nine) British Columbia (two), Hawaii (one), Virginia (one), and New Zealand (one).

Does your agency notify the public in the case of an impending Tsunami? 16 of the 21 responding to the survey were responsible for warning the public of an impending tsunami.

The second question was to determine what types of outside warning sirens are being utilized. Six surveyed agencies used warning sirens for dam failure or flooding. Six used sirens for hazardous chemical release. Five surveyed agencies used sirens for tornado, hurricane or other severe weather. 13 responders were using sirens for tsunami warning. In one agency, sirens are used to warn of volcanic eruption or lost child. Four agencies indicated that sirens were part of an all hazard system and could be used for any of the events listed above.

Question three asked: What type of public warning system is used in your community? Nine have fixed mounted electronic sirens with voice message compatibility. Eight have fixed mounted mechanical sirens without any voice message. Eight agencies use mobile sirens with voice messages. Nine agencies utilized a reverse-911 phone system. Eighteen agencies used national or state radio emergency broadcast systems, including NOAA. Fourteen agencies

utilized a local emergency radio broadcast. One agency used marine band radios to warn marine vessels. Another agency has tone alert radio in all homes and businesses, while two agencies notified the public by driving through the neighborhoods alerting citizens with public address (PA) systems. Research also uncovered one park ranger who notifies each camper to evacuate State Park campground, and one fire department issued pagers carried by various organizations who are party to the Emergency Planning process. This indicates that of the 21 agencies responding to the survey, six indicated they did not use outside warning sirens. Of the fifteen agencies using fixed mounted sirens, seven (47%) of the systems have voice message capability; six (47%) are non-voice mechanical systems; and two (13%) have mixed systems where a limited number of sirens have voice capability.

The fourth question asked: What is the intended message of the public warning siren system? The majority of those responding, 10 of the 16 indicated they wanted the public to evacuate immediately and then seek more information from radio or television. One indicated to shelter in place and tune to radio or television for more information. Two indicated tune to radio or television for more information, and five of those answering the survey indicated any of the above depending upon type of emergency. The agencies that indicated their system had the flexibility to be used for hazard emergencies have voice message capable systems. Question five asked: How long before the wave inundation do you broadcast the first public warning issued? The answers that six agencies indicated were that the advance warning time varied depending on circumstances of the situation. One was unsure of the advance warning time, two indicated two-hours before first wave arrival, and three said three hours before first wave arrival. Two indicated as soon as possible after received warning due to potential short wave travel distances. A park ranger began warning campers immediately after receiving a warning and a State level

official indicate that the State Emergency Operation Center (EOC) transmitted warnings to local officials immediately after receiving an alert from Tsunami Warning Center.

Question six asked: If using facility mounted sirens, what type of siren sound is used and for what duration? Six agencies used a “wavering” tone cycle, one sounded for a duration of 4-minutes, four used a duration of 3-minutes, and one a duration of 1-minute followed by a voice message. Seven agencies used a “non-wavering” tone cycle, and of those, four have a duration of 3-minutes, one has a duration of 15 to 30-seconds, one a duration of 1-minute, and one was uncertain of duration. One agency did not indicate the type of siren sound used. Four agencies give voice messages after the siren tone. Two have a mixed system where some sirens have voice capability and others do not. Only six agencies indicated the use of a voice message in response to this question. In question three, nine agencies indicated having siren systems with voice message capability.

Question seven asked: After the first siren warning is given, is the siren warning repeated and how often? Five agencies repeated siren signals, one repeated voice message only. Three agencies indicated they did not repeat the siren warning. Three of the five agencies that do repeat the siren indicated it is repeated every 15-minutes. Other than this, there appears to be no consistency in repeated warnings.

Question eight asked: If sirens are used to signal when the Tsunami Warning is canceled and “All Clear”. Three agencies answered yes to using a siren to signal an all clear. One agency uses a solid tone for 15 seconds, one an air horn followed by a voice message and two used voice message only. Seven agencies answered “no” when ask if sirens were used to signal an “all clear” indicating the end of the warning. Three agencies did not respond to this question and six reported the question was not applicable to their agency.

Question nine asked: How often are sirens tested in your community? Eight were tested weekly, six tested monthly, and one has no regular scheduled test. One responder represented more than one agency operating sirens, and indicated that the test frequency varied with each agency.

Question 10 is a follow up question asking for a description of the siren test used. Three agencies did not report the type of test sound used. Of those who responded, there were few consistencies in answers; two agencies used Westminster Chimes; other tests were described as: Wailing, Westminster Chimes followed by 90-second non-warbling siren, Wavering tone 45-seconds, Solid tone 15-seconds & voice message, Wavering tone 30-seconds, Cow mooing & voice message, Solid tone 15-20 seconds, and Voice test message only. When compared to the answers in question six, asking what warning sound is used, it is clear that some of the warnings used in communities could be mistaken for a test in others, or the other way around. Three agencies used siren signals of 60-seconds or less as warning signals.

Question 11 asks if a visual warning is used in conjunction with warning sirens. Four agencies use strobe or flashing lights mounted to the sirens, three use blue strobes and one uses white. One agency uses changeable message signs but did not describe further. Some agencies have emergency vehicles drive through inundation zones using lights and PA. One agency has aircraft that fly low with blue flashing lights, siren and PA system. One agency indicated the LED screen displays warning messages on NOAA Radio. One agency was uncertain if there was a visual component as part of the warning sirens.

Question 12 asked: Does your agency have a formal public education program about your public warning system? Sixteen agencies responded “yes” to having an education program about their public warning systems; two responded “no”; and two felt the question was not

applicable to their agencies. Based upon the comments, the question was addressed in the broadest terms of tsunami public education.

Question 13 asked: What other uses are sirens being used for in your community?

Examples of other uses would be alerting of volunteer personnel for fires, and noontime chimes or bells. Eight agencies report no other uses in their community, and seven did not respond to the question. Two were unsure of other uses and one has a noon time siren. Two agencies reported outdoor sirens were used to alert volunteer firefighters. One used sirens to signal water and sewer failures.

In question 14, those surveyed were asked at what level of government their siren warning policy was established. Two agencies were operating under a National Policy, two were operating under a State level policy, five operate under a County or regional policy and six operate under a local government policy.

Question 15 asks if test have been conducted to determine the effectiveness of their warning system. Fourteen responded “yes”, three have not tested their systems and one was uncertain.

Question 16 asked: Do you feel confident that your public warning system will adequately warn the public? Eleven of those providing tsunami warning felt confident that the public would be adequately warned. Four of the agencies providing warnings were uncertain if their warning system was sufficient. Four of the agencies did not feel their warning system was adequate. Two agencies did not respond. Some agencies indicated that there were gaps in coverage due to budget restraints; others indicated that the amount of advanced warning they received would determine if they could warn all the populations required.

Question 17 asked if they feel there is a need for a Uniform Siren Signal Standard for Tsunami Standard? Seventy-six percent (16) of those responding to the survey answered “yes” to needing a uniform siren signal standard. Fourteen-percent (3) indicated they were uncertain if a uniform standard was needed. Five percent (1) of those responding to the survey felt no standard was needed. Five percent (1) of the agencies did not respond to question 17. Comments included: “systems should have voice message”; “I don’t think it matters”; “I don’t think it matters; our system has operated for twenty years with several evacuations...leaves no question as to what is going on or what to do. I don’t believe it is our concern what other communities use”; and “could not agree more!”

Question 18 asked: At what level of government do you think a Uniform Siren Signal Standard for Tsunami Standard should be adopted? Twenty-four percent (5) indicated a standard should be established on a Multi-National level. Twenty-nine percent (6) indicated a National level standard. Thirty-three percent (7) indicated the standard should be at a State level. Five percent (1) indicated the standard should be set at the local level and five percent (1) did not respond to the question. Comments included: “State and Local, because needs vary so significantly; but need remains to coordinate EAS code activation”; “Starting with the State level, a goal would be to standardize it nationally second, then internationally”; “Would support State, but could also support National”.

Question 19 allowed survey responders to make comment on the subject. Comments are included in appendix-B with the survey results.

What type of public tsunami warning systems are currently used in the five western states—Oregon, California, Washington, Alaska, Hawaii and locations in and around the Pacific? Nine agencies utilized a reverse-911 phone system. The survey results show that 18

agencies use national or state radio emergency broadcast systems, this includes NOAA. Fourteen agencies utilized a local emergency radio broadcast; this would include the EAS. Other systems described were using marine band radios to warn marine vessels. One agency has tone alert radios in all homes and businesses. Three agencies were using vehicle delivered warnings. One fire department issued pagers carried by various organizations who are party to the Emergency Planning process. Of the 15 agencies using fixed mounted sirens, seven or 47% of systems have voice message capability systems, six or 40% are non-voice mechanical systems and two or 13% have mixed systems where limited numbers of sirens have voice capability. The reader is reminded that in most cases, systems are being used in conjunction with other system and not exclusively. The survey results were consistent with what information was found from the literary review: that there is a wide variety of methods and technologies being utilized to disseminate public warnings and that most employ multiple methods (DOGAMI 2001) (Jefferson County 2008) (Kenai Peninsula Borough 2008) (Hawaii 2003) (Gregg 2006).

What recognized standard currently exists for public siren-warning systems in the United States? FEMA (1980) sets a standard for the use of outdoor warning sirens in the United States in the Outdoor Warning Systems Guide. This standard is 28 years old; The White House (2006) issued Executive Order 13407 over three years ago, where President Bush directed the updating of Public Alert and Warning System.

The survey results show the Outdoor Warning Systems Guide is only being followed as a guideline; some agencies follow some recommendations but not all. Such as only four agencies indicated they used the three-minute steady alert tone; and only two stated the intended meaning of the sirens was to tune to radio or television for more information, as recommended by FEMA

(1980). When, at whatever level their siren policy had been adopted, 11 were county/regional or city/local policies.

Does evidence exist that supports one type of siren sound being more effective than another? FEMA (1980) states that first the siren sound must be able to be heard over the ambient noise level of the surroundings of the listener. Second, it must get the attention of the listener; to do this studies have shown that the siren must exceed the ambient noise level by nine (9) decibels. This researcher could not find any empirical research that supported one siren sound being more discernable over another, or any information regarding how sound is affected by terrain, wind, buildings and other topographical items (FEMA 1980) (Anderson 2006).

Sorensen, J., and Mileti, D., (1990) state that people do not remember what different siren sounds mean, but will seek out information if sirens are sounding for an extended time period. Sorensen, J., and Mileti, D., (1990) describe the warning response process as: hearing, understanding, believing, personalizing, deciding and responding, this being a complex process which hearing is only the first step. Sorensen, J., and Mileti, D., (1990) point out that few empirical findings show why warnings were or were not heard; they speculate that few have been researched because an assumption is being made that warnings are being heard. Sorensen, J., and Mileti, D., go on to point out that evidence exists to show it would be inaccurate to assume that, because warnings are issued, they were heard. What other uses are facility-mounted warning sirens being used for within communities located in tsunami zones? The survey results show that two were unsure of other uses and one has a noon time siren. Two agencies reported outdoor sirens were used to alert volunteer firefighters. One used sirens to signal water and sewer failures. Seven responders to the survey did not respond to this question.

Discussion

What type of public tsunami warning systems are currently used in the five western states—Oregon, California, Washington, Alaska, Hawaii and locations in and around the Pacific? The survey results were consistent with what information was found from the literary review: that there is a wide variety of methods and technologies being utilized to disseminate public warnings and that most employ multiple methods (DOGAMI 2001) (Jefferson County 2008) (Kenai Peninsula Borough 2008) (Hawaii 2003) (Gregg 2006).

The survey results show that 15 agencies using fixed mounted sirens; seven or 47% of systems have voice message capability systems, six or 40% are non-voice mechanical systems and two or 13% have a mixed systems where limited number of sirens have voice capability. This would indicate that an updated uniform siren standard must continue to address both electronic-voice and electro-mechanical sirens as FEMA (1980) currently does.

Another consideration is that many agencies use the sirens as an all-hazard warning alert (Jefferson County 2008) (Kenai Peninsula Borough 2008) (Hawaii 2003), and not all have voice-complete voice capable sirens. This is the reason FEMA (1980) stated the alert tone means tune to radio or television for more information, the sirens are for getting the listener's attention and not to signal protective action. In question four, 10 of the 16 agencies using sirens indicated the meaning of the siren meant evacuate immediately and then tune to radio, a protective action. FEMA (1980) offers a third unique tone option for specific local government requirements. In theory a unique tone could be agreed upon for tsunami or flood warning that means evacuate immediately. This would allow for the system to be used as an all-hazard system. Research conducted by Sorensen, J., and Mileti, D., (1990) indicated that people do not remember what different siren sounds mean, but will seek out information if sirens are sounding for an extended

time period. Therefore, they recommend sirens are best used as an alert device to prompt people to seek more information. This research supports the sirens as best used as an alert sound to seek more information. Even though Sorensen, J., and Mileti, D., do not recommend sirens alone be used to prompt a protective action from the public, they make an exception to this where drills are conducted to the point that the actions become an automatic. This indicates that sirens might be as effective as an immediate evacuation warning in select locations such as schools, industry or other locations where drills can be incorporated into emergency plans and practiced regularly.

What recognized standard currently exists for public siren-warning systems in the United States? The FEMA (1980) Outdoor Warning Systems Guide CPG 1-17 is the National standard of the United States. Yet the survey results clearly show most do not follow this standard and in Hawaii where the standard is followed, a survey conducted in 2006 shows that understandings of sirens have not increased significantly from the low levels of the 1960's. Awareness of the siren tests were high, on average 84% of those surveyed were aware of the siren test; and 77% were aware tests were conducted monthly. When asked the meaning of the siren, 69.7% of students and 50.4% of adults answered "don't know". Of those surveyed, 47.9% of students and 48.1% of adults answered "other" (emergency, disaster, alert, tsunami, flood, etc.). Less than 1% of students and 13.1% of adults answered correctly: tune to radio/television (Gregg, C.E 2006).

Does evidence exist that supports one type of siren sound being more effective than another? FEMA (1980) and Anderson (2006) both provide information related to sound and the hearing of sirens in general. Both FEMA and Anderson agree that the voice siren range of understanding is much more limited than the siren sound. This is consistent with survey comments regarding the use of voice sirens. FEMA (1980) says two factors determine if sirens are effective in alerting the public. First, the siren sound must be able to be heard over the

ambient noise level of the surroundings of the listener. Second, it must get the attention of the listener. To do this, studies have shown that the siren must exceed the ambient noise level by nine decibels. Anderson (2006) states the standard rule for overcoming background noise is 10 decibels over the ambient noise level, and that normal surf and wind is approximately 70 decibels. Therefore, a siren used in a beach environment would need to produce a minimum of 80 decibels to the listener. The effective range of a siren is determined by natural/human-made topography, weather, distance and ambient noise (Anderson 2006) (FEMA 1980). Whether or not a siren is loud enough to be heard is an engineering problem, and should be approached with proper planning and evaluation of the system.

This question was written under the incorrect assumption by this researcher that, if the public hears the siren, with proper public education they will take the correct action. I was viewing public response to sirens as an engineering problem, when it is mostly an adaptive problem. Sorensen, J., and Mileti, D., (1990) describe the warning response process as: hearing, understanding, believing, personalizing, deciding and responding. Hearing is only one of the five steps of the warning process. Factors affecting the message being heard are: actual inability to hear due to physical constraints, selective perception, and inattention to media delivering message. Sorenson (2000) states there is no conclusive evidence that shows that public education increases the likelihood of a desired response to warnings from the public. Sorenson goes on to explain that it is likely that good pre-emergency information will likely improve response, though the amount can not be estimated; and a poor program will likely not make a difference.

What other uses are facility-mounted warning sirens being used for within communities located in tsunami zones? Only three other uses were identified by the survey, two to alert firefighters and one to alert water/sewer system failure. This researcher's concern was that

multiple sirens, chimes or similar devices being used might cause confusion. If this was addressed during the local planning of the operation of a warning system, any potential problems can be avoided. The survey did show where one agency used a 15-second steady tone to signify an all clear and there were three other agencies that used warning siren tones from 15 to 60 seconds. This demonstrates that without a uniform siren warning system to follow, sirens will not be sending clear message as to correct actions.

North Lincoln Fire & Rescue operates a tsunami warning system using electro-mechanical sirens. Currently the sirens mean move to high ground and seek more information. This research challenges our assumption that the public will take this protective action.

Recommendations

North Lincoln Fire & Rescue should conduct a survey to evaluate the public's understanding of the sirens. Based upon survey results, current practice should be evaluated in both operation and public education of the tsunami siren system.

Sorensen, J., and Mileti, D., (1990) in section-3 of "Communications of Emergency Public Warnings, A Social Science Perspective and State-of-the-Art Assessment" provided information on building and evaluation of a warning system based upon empirical research. This is highly recommended reading to any organization involved in dissemination of public warnings.

My research questions were based upon finding a clear, concise and flexible siren warning system, and to provide adequate coverage to be heard. My assumption was, if we accomplished this then people would follow the instructions of the warning and take the actions we desired; research shows this is not the case. Future researchers on this subject should consider

the adaptive nature of public warnings when forming their research questions. In doing so, consider what people's natural responses are and process when reacting to public warnings.

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Appendix A

Survey

Tsunami Warning Siren Survey

Thank you for taking the time to complete this survey. I am an Executive Fire Officer Program (EFOP) student at the National Fire Academy (NFA). The survey is part of an applied research project in conjunction with the EFO Program. The results of the survey and research paper will be available early in 2009; if you have questions or wish to request the results, my contact information is below.

Don Baker, Fire Chief
 North Lincoln Fire & Rescue District #1
 PO Box 200
 Lincoln City, Oregon 97367
 Email: dbaker@nlfr.org

Your agency information:

Agency _____ Contact Person _____
 Location _____
 Email _____ Phone Number _____

1. Does your agency notify the public in the case of an impending Tsunami?
 Yes No
2. Does your agency uses outside warning sirens to warn the public in the event of:
 (mark all that apply)
 - A) Dam failure (flooding)
 - B) Hazardous chemical release
 - C) Tornado, hurricane (severe weather)
 - D) Tsunami
 - E) Other or multiple uses _____

3. What type of public warning system is used in your community? (Circle all that apply.)

- A) Fixed Mounted Siren Electronic (voice message capable)
- B) Fixed Mounted Siren Mechanical (no voice)
- C) Mobil Sirens (vehicle)
- D) Automated Phone Calling System (Reverse 911)
- E) Radio Emergency Broadcasts (national or state system)
- F) Local Emergency Radio Broadcasts (county, city, or agency operated)
- G) Other (please describe) _____

4. Please complete the following sentence. The intent of the Public Warning Siren in our community is to inform the public to...

- A) Evacuate Immediately and Tune into Radio or Television
- B) Shelter in Place and Tune into Radio or Television
- C) Tune into Radio or Television for more information.
- D) Other _____

5. How long before the wave inundation do you broadcast the first public warning issued?

Hours_____ Minutes_____

6. If using facility mounted sirens, what type of siren sound is used and for what duration? (mark all that apply)

- A) Wavering (tone cycle) Duration _____
- B) Non Wavering Siren Duration _____
- C) Other Siren Tone (describe) _____
- D) Voice Message given in conjunction with siren Yes / No

7. After the first siren warning is given, is the siren warning repeated and how often?
 Example: Sirens are sounded three hours before inundation and every fifteen minutes (15-minutes) after, until warning is canceled.
 Yes Yes (Voice Message Only) No
 Every 15-minute
 Every 30-minute
 Other _____
8. Do you use sirens to signal when the Tsunami Warning is canceled and "All Clear"?
 Yes No
 If yes, what type of siren tone is used and for what duration?
 Siren tone_____ Duration_____
9. How often are sirens tested in your community?
 A) Daily B) Weekly C) Monthly
 D) No Test Schedule E) Not Tested
 F) Other_____
10. Please describe your siren test sound and duration. (Example- Solid blast 20-30 seconds in duration)
 Describe _____
11. Do you use a visual warning component in conjunction with warning sirens?
 Yes No
 If yes, describe type of device, color of light etc. _____
12. Do you have a formal public education program about your public warning system?
 Yes No
13. What other uses are sirens being used for in your community? Examples of other uses: alerting of volunteer personnel for fires, noontime (chimes, bells, and siren). Churches using chimes. If used, please describe the type of sound being used and for what purpose.

14. Please indicate the level at which your Siren Warning Policy was established, and who established the policy?
- A) National level policy
 - B) State level policy
 - C) County or regional
 - D) Local city or agency
15. Have tests been conducted locally to determine the effectiveness of your warning system?
- Yes No
16. Do you feel confident that your public warning system will adequately warn the public?
- Yes No Unsure
17. Do you feel there is a need for a Uniform Siren Signal Standard for Tsunami Standard?
- Yes No Unsure
18. At what level of government do you think a Uniform Siren Signal Standard for Tsunami Standard should be adopted?
- A) Multi-National B) National C) State D) County/Regional
- E) Local
19. Do you have any other comments regarding this subject?

Please email or mail survey to the address above.

Thank you, Don Baker

Appendix B

Survey Results

1. Does your agency notify the public in the case of an impending Tsunami?
Yes (16) No (5)

2. Does your agency uses outside warning sirens to warn the public in the event of:
(mark all that apply)
 - A) Dam failure (flooding) (6)
 - B) Hazardous chemical release (6)
 - C) Tornado, hurricane (severe weather) (5)
 - D) Tsunami (13)
 - E) Other or multiple uses (4),
 1. Volcanic eruption, lost child (1)
 2. NOAA Weather Radio Tone Alert for life threatening Natural Hazards
 3. No sirens at Bullards State Beach, some State Parks in Curry County have sirens.
 4. Primary use is tsunami warning, all hazards capable.
 5. No siren system at this time, goal to have one in place 2009

3. What type of public warning system is used in your community? (Circle all that apply.)
 - A) Fixed Mounted Siren Electronic (voice message capable) (9)
 - B) Fixed Mounted Siren Mechanical (no voice) (8)
 - C) Mobil Sirens (vehicle) (8)
 - D) Automated Phone Calling System (Reverse 911) (9)
 - E) Radio Emergency Broadcasts (national or state system) (15)
 - F) Local Emergency Radio Broadcast (county, city, or agency operated) (14)
 - G) Other (please describe)
 1. NOAA Weather Radio (3)
 2. Marine Band Radio (1)

3. Tone alert radio in every home and business, strobe available. (1)
 4. TV channels carry emergency message (1)
 5. Notifying by driving through the neighborhoods alerting citizens with PA Systems. (2)
 6. Coos County OME & Coos 911 has notifies me by phone, so that I can evacuate park.
 7. Fire Department activates pagers carried by various organizations who are party to the Emergency Planning process.
4. Please complete the following sentence. The intent of the Public Warning Siren in our community is to inform the public to...
- A) Evacuate Immediately and Tune into Radio or Television (10)
 - B) Shelter in Place and Tune into Radio or Television (1)
 - C) Tune into Radio or Television for more information. (2)
 - D) Other
 1. Any of the above depending on emergency (5)
 2. As determined by individual community.
 3. Evacuate immediately – without delay
 4. I would not know what to do in the event of a siren in Newport
 5. Take appropriate action, monitor situation closely
5. How long before the wave inundation do you broadcast the first public warning issued?
NA (5)
- Hours_____ Minutes_____ Varies (5) Don't Know (1)
- 2-hours (2) 3-hours (3)
1. State EOC notifies communities immediately following warning issued by West Coast/Alaska Warning Center; in turn each community follows local procedures.
 2. As soon as possible after warning received, due to short wave travel distances.
 3. One to Three hours for distant tsunami. (1)
 4. As soon as I am notified I inform campers in park.

5. As soon as possible once confirmation is received from the Pacific Tsunami Warning Center.
6. If using facility mounted sirens, what type of siren sound is used and for what duration? (mark all that apply)
- NA (7)
- A) Wavering (tone cycle) (5) Duration: 4-Minutes (1) 3-Minutes (4)
 One minute followed by voice (1)
- B) Non Wavering Siren (6) Duration: Unknown (1), 3-minutes (4)
 15-30 seconds (1) Sixty 60- seconds (1)
- C) Other Siren Tone (describe) (1) not described, followed by voice message
- D) Voice Message given in conjunction with siren Yes (4) / No (1)
 No Response (1) System has both voice and non-voice. (2)
7. After the first siren warning is given, is the siren warning repeated and how often?
 Example: Sirens are sounded three hours before inundation and every fifteen minutes (15-minutes) after, until warning is canceled. NA (6)
- Yes (5) Yes (Voice Message Only) (1) No (3)
- Every 15-minute 3
- Every 30-minute
- Other Unknown (2), No Response (1),
1. Three minutes repeated every 30-second (1)
2. Voice message is repeated four times after initial siren, nothing more till all clear.
3. INITIAL at 3-hours, 2-hours, 1-hour, 30-minutes, 15-minutes, 5-minutes.
4. NOAA Weather Radio only
5. Repeated no fixed interval determined.
8. Do you use sirens to signal when the Tsunami Warning is canceled and "All Clear"?
 NA (6) Yes (3) No (7) Not Reported (3)
- If yes, what type of siren tone is used and for what duration?
- Siren tone Duration
- Solid tone for 15 seconds

-“Air Horn” tone followed by voice message

Voice message only (2)

9. How often are sirens tested in your community? NA (6)
 A) Daily B) Weekly (8) C) Monthly (6) (first work day of each month, HI)
 D) No Test Schedule (1) E) Not Tested
 F) Other: No Response (1)
 Varies with community 20 to 30 second solid blast

10. Please describe your siren test sound and duration. (Example- Solid blast 20-30 seconds in duration)
 NA (6)
 Describe _Not Reported 3
 1. Waling
 2. Westminster Chimes followed by 90-second non-warbling siren.
 3. Wavering tone 45-seconds
 4. Westminster Chimes (2) 5. Solid tone 15-seconds & voice
 6. Wavering tone 30-seconds 7. Cow mooing & voice
 8. Solid tone 15-20 seconds. 9. 8-second Tone NOAA Radio
 10. Voice test message only

11. Do you use a visual warning component in conjunction with warning sirens?
 NA (6)
 Yes (7) No (7) Unknown (1)
 If yes, describe type of device, color of light etc.
 1. Changeable message signs 2. Blue flashing light
 3. Aircraft with blue flashing light, siren & PA systems
 4. White strobe 5. Fire & Police Vehicles
 6. Two of six sirens blue strobe lights
 7. LED screen displays warning message on NOAA Radio

12. Do you have a formal public education program about your public warning system?

NA (2) Yes (16) No (2)

Comments:

1. DOGAMI is involved in public education regarding tsunami hazards and evacuation zones across the State.
2. We talk about tsunamis at our evening programs, and as part of volunteer orientation.
3. Not yet, but working on developing a program.

13. What other uses are sirens being used for in your community? Examples of other uses: alerting of volunteer personnel for fires, noontime (chimes, bells, and siren). Churches using chimes. If used, please describe the type of sound being used and for what purpose.

Alert Volunteer firefighters	(2)
Not Reported	(7)
None	(8)
Noon siren	(1)
Unknown	(2)
Water & Sewer failures	(1)

14. Please indicate the level at which your Siren Warning Policy was established, and who established the policy? NA (6)

- A) National level policy (2)
- B) State level policy (2 CA, HI)
- C) County or regional (5)
- D) Local city or agency (6)

15. Have tests been conducted locally to determine the effectiveness of your warning system?

NA (2) Yes (14) No (3) Unsure (1)

16. Do you feel confident that your public warning system will adequately warn the public?

Yes (11) No (4) Unsure (4) No Response (2)

Comments:

1. All areas of Coast line note covered.
2. Unsure, For the most part YES, with enough time, enough personnel and all systems operate.

3. We need warning sirens in the State Park. I would like to hook up to Bandon's system but no money in budget for this.
4. Current system in our community is not adequate.
5. There is no fool safe method. Our tsunami warning system will cause a majority of people in the inundation zone to seek further information or immediately evacuate.

17. Do you feel there is a need for a Uniform Siren Signal Standard for Tsunami Standard?
 Yes (16) No (1) Unsure (3) No Response (1)

Comments:

1. Should have voice message
2. I don't think it matters; our system has operated for twenty years with several evacuations...leaves no question as to what is going on or what to do. Don't believe it is our concern what other communities use.
3. Could not agree more!

18. At what level of government do you think a Uniform Siren Signal Standard for Tsunami Standard should be adopted?
- | | | |
|------------------------|-----------------|-----------------|
| A) Multi-National (5) | B) National (6) | C) State (7) |
| D) County/Regional (1) | E) Local (1) | No Response (1) |

Comments:

1. State, Local, because needs vary so significantly; but need remains to coordinate EAS code activation.
2. Starting with the State level. A goal would be to standardize it nationally second, then internationally.
3. State, could also support National

19. Do you have any other comments regarding this subject?
1. County has Tsunami Hazard Zone Signs posted however the signs do not give instructions of what to do incase of an emergency.

2. Our worst case scenario is a locally generated tsunami that comes from the Big Island of Hawaii and arrive at our shores in 40 minutes. We are lucky to have the Pacific Tsunami Warning Center on Oahu to do the science and advance warning.
3. All coastal areas should have some sort of warning system.
4. Anyone starting out to make one of these systems needs to understand that in coastal conditions like ours the siren units should not be the “360°” type (pancake speakers). Reason is that their sound output radiates 360° when there’s no wind. Wind too easily blows their sound pattern downwind, leaving the upwind area very weakly covered if at all. We’ve had that experience – and will never buy any more of that style unit. Instead, we favor the projector type speaker unit – which we aim to cover the area to be warned. They’re less sensitive to wind compromising their coverage.

We also have learned that solar technology to date can’t effectively keep our batteries charged adequately – requires too many panels. We trickle-charge from the street light system. We can, of course, charge the batteries from a mobile system if necessary when there’s prolonged failure of commercial power. Also, we’ve learned to use four (4) six volt batteries rather than two (2) 12 volt ones to develop our 24 volt power. The six volt batteries are heavier built, sturdier electrically, and we’ve found far more long-lasting and reliable. Much less expensive over the long run.

As to our voice announcements, we don’t favor the pre-recorded chip system. Instead, we favor flexibility of recording our messages ourselves using mini-disk technology and those pre-recorded messages are broadcast to the siren stations from central control (running on auxiliary power if necessary). DTMF codes required for system operation are recorded integrally with those messages.

Experience taught us such recording cannot be relied upon if done using digital audio tape. Such tape can and does work, maybe more than a hundred times – but then can fail. Whereas, higher precision of mini-disks avoids such problems. We will someday upgrade to DVD.

As to the physical equipment itself: Ocean atmosphere requires strict requirements metallurgically. We now use restaurant-grade (food service grade) stainless steel alloy, and hot-dipped galvanizing, PVC coated/lined steel conduit, etc to thwart deterioration common to lesser quality materials. For the long run, again, less

maintenance expense.

4. I'd like to see State Parks come up with some funding for sirens at coastal campgrounds and high visitation day use areas.
5. We are not a coastal region, we did have horns many years ago from early wars days but were removed many years ago.
6. The Municipality of Anchorage is not threatened by Tsunami waves generated in the Pacific. At one time there were sirens in the community but they have since been removed. Other communities such as Homer, Seward and especially Kodiak have active siren systems and programs.
7. Our community is not exposed to a tsunami threat, the planned siren system will be used for hazmat, earthquake, and large scale disasters.